



CASE REPORT

Femoral shaft fractures in patients with severe cerebral palsy fixed with humeral nails A report of two cases and a new technique of surgical stabilization

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Introduction

Fractures are not uncommon in individuals with severe cerebral palsy (CP) because their bones usually have very low mineral density, deformity and developmental disability. These fractures are often treated non-operatively but sometimes result in mal-union or non-union of the fracture. Some femoral fractures require open reduction and internal fixation, but there have been few papers discussing suitable implants for difficult fractures in these patients.

Case reports

Case 1

A 34-year-old man with CP sustained a fracture of the left femur. In addition to motor disabilities he

had other associated disabilities: learning disabilities, failure to thrive in infancy and poor growth in childhood, and scoliosis (Fig. 1A). He was taking anticonvulsant medication. His bones were demineralised and thin and the general bone density was very poor. Bone density was measured with dual-energy X-ray absorptiometry (DEXA; Hologic QDR 4500A; Waltham, MA, USA). His bone mineral density (BMD) was 0.748 g/cm² and young adult mean (YAM) was −2.52 (71%) on A–P lumbar spine. The fracture had occurred when he had been lifted gently upwards by the upper limbs by a physiotherapist during rehabilitation on a floor mat, and the left leg had twisted. Radiographs performed on arrival confirmed an AO type A1 fracture of the left femoral shaft (Fig. 1B and C). Seven days after injury, he underwent operative treatment with plate fixation (Fig. 2A and B). Seven months after operation the fracture was healed. When being gently lifted from his bed by nurses 10 months after the first injury, the left leg was caught and he sustained a fracture at the top of the plate. Radiographs confirmed an AO

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Figure 1 Case 1 (A) Usual position and shrunken limbs of case 1 with CP. (B) and (C) The first fracture, AO type A1 fracture of the left distal femoral shaft. The narrowest internal diameter size of this femur is less than 8 mm and the cortex is very thin.

type B1 fracture (Fig. 2C and D). We performed a closed reduction and applied a cast from trunk to foot with the hip flexed 90° and abducted 30°. The patient had nerve palsy, emotional problems and showed some irritability and therefore could not be managed with this hip spica cast. In addition, the cast failed to maintain proper length and alignment, so internal fixation was planned six days after the second injury. This operation was carefully planned following radiographic examination and using X-ray templates for a 7 mm humeral nail. The patient was placed in a dorsal–lateral position on a radiolucent operating table. Under general anaesthesia, the entire extremity was prepared and draped. The femur was approached laterally to remove the plate and screws. Next the upper end of the femur was approached through a 5 cm longitudinal incision proximal to the greater trochanter and in line with the femoral shaft. A threaded-tip guide-wire was inserted into the entry point at the proximal tip of the greater trochanter, followed by proximal reaming with an 8 mm reamer. This allowed the nail to be inserted smoothly into the distal femur and fit within the femoral cortices. The nail was locked with a proximal locking screw and two distal locking screws in static mode. A T2™ humeral nail (Stryker®) 7 mm diameter, 260 mm length provided a good fit in this unusual femoral fracture (Fig. 3A and B).

No cast was applied after surgery and the patient did not complain of pain. As he did not walk or stand, weight bearing was not a concern. The fracture healed by three months (Fig. 3C and D). Eight months after the second operation there were no complications or problems with post-operative management.



Figure 2 Case 1 (A) and (B) Initial plate and screw fixation. (C) and (D) AO type B1 fracture at the top of plate fixation 10 months after the first operation.



Figure 3 Case 1(A) and (B) Intramedullary nailing using a 7 mm diameter, 260 mm length T2™ humeral nail (Stryker®). (C) and (D) The fracture was fully healed three months after operation.

Case 2

A 30-year-old man with CP sustained a right femoral fracture. In addition, he had motor disability based on a subtype of muscular dystrophy and other associated disabilities similar to case one (Fig. 4A). In addition, he had epilepsy and asthma and was taking anticonvulsants. Bone density was measured with dual-energy X-ray absorptiometry (DEXA; Hologic QDR 4500A; Waltham, MA, USA). BMD was 0.833 g/cm² and YAM was -1.80 (80%) on A-P lumbar spine.

Because of the need for regular position changes he had been rolled gently onto his side as part of his nursing care. The right leg had twisted, there was a palpable click and his mood changed. Radiographs confirmed AO type B1 fracture of the right femoral shaft (Fig. 4B).

As in the first case, we felt the complex medical problems meant this patient could not be managed in a cast, so internal fixation was performed seven days after injury as in the previous case.

Under general anaesthesia, the upper end of the femur was approached through a 4 cm longitudinal incision proximal to the greater trochanter and in line with the femoral shaft. A threaded-tip guide-wire was inserted into the lateral entry point from the proximal tip of the greater trochanter, followed by proximal reaming with an 8 mm reamer. A T2™ humeral nail, 7 mm diameter, 240 mm length, was locked in static mode with a proximal locking screw and two distal locking screws (Fig. 4C). The key points for smooth and safe operation were the postero-lateral entry point and gentle insertion of the nail with minimal force.

There was minimal post-operative pain. Three months after surgery the fracture had not united (Fig. 4D), but at seven months the fracture had healed (Fig. 4E).

Discussion

Fractures frequently occur in individuals with moderate to severe CP. Low bone density, stiff joints, poor balance leading to falls, and violent seizures are all contributory factors.^{2,10,11,13,15,19,21,22} In a reported series of non-ambulatory adults, nearly 20% had sustained a femoral fracture at some time in their life.²¹ Usually these fractures are treated non-operatively, resulting in mal-union.^{2,4,5,20,21} Approximately 90% of all CP patients survive to adulthood. Femoral fractures may reduce their quality of life and add to their care requirements over a long period.²⁰ Proper treatment of femoral fractures is clearly helpful in these CP patients.^{4,5,15}

The management of femoral fractures in severe CP patients is a major challenge. Because of impairments such as muscle spasticity, muscle weakness and uncontrolled muscle movement, non-operative treatment often fails⁶ and surgery is indicated, however, there are few papers describing operative techniques for these fractures. Some authors recommend open reduction and internal fixation with plate and screws (the first operation for case one) in selected cases under the age of 11 years.⁶ However, plate fixation involves some problems, such as a long incision, plate breakage and stress fracture after removal of the plate. Comparative studies¹⁶ as well as retrospective reviews of traction and casting suggest that femoral fractures in CP

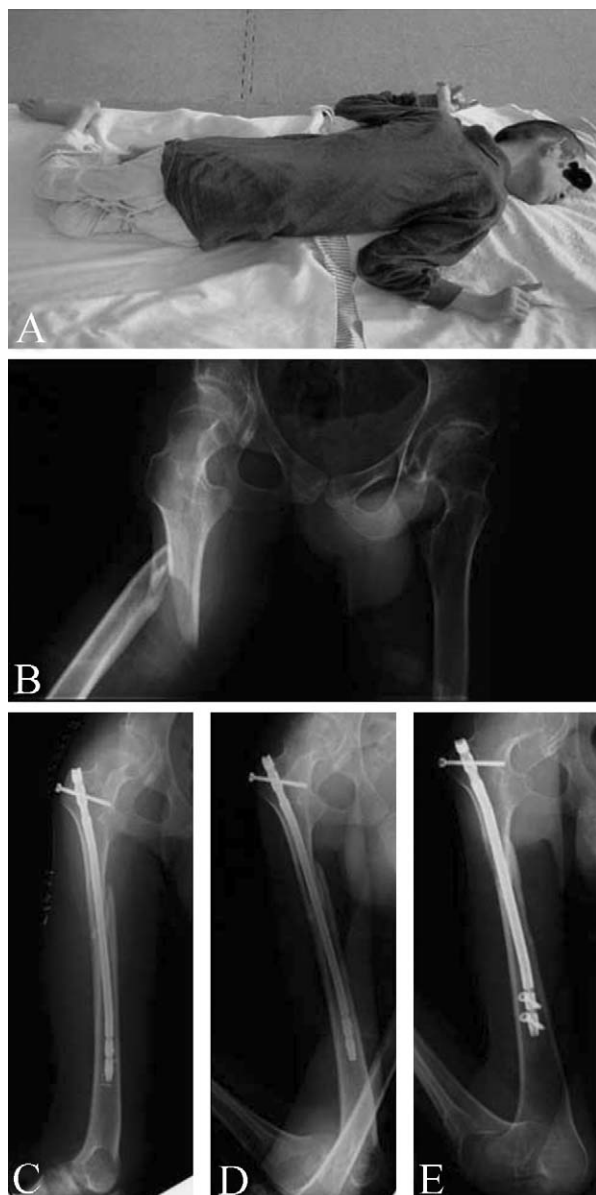


Figure 4 Case 2(A) Usual deformed position of trunk and limbs. (B) AO type B1 fracture of the right femoral shaft. (C) Fixation using 7 mm diameter, 240 mm length T2™ humeral nail (Stryker®). (D) Three months after surgery the non-union state is persistent. (E) The fracture has healed seven months after operation.

adolescents are better treated with intramedullary fixation than with conventional traction and casting. Flexible intramedullary nailing using either stainless steel (Ender nail) or titanium (Nancy nail) nails can be performed either antegrade or retrograde.^{6,7,9,12,18} Even if such nails are properly inserted, it is unclear whether fracture fixation and stability is sufficient for CP patients. The lack of stability induces post-operative pain and, therefore, a long period of post-operative casting is required.^{8,17}

Interlocking nail systems are the best option for achieving rigid fixation with these femoral fractures, however, special designs are necessary for CP patients.^{1,3,6,14,23} Preoperative radiographs showed the diameter for a suitable femoral nail was 7–8 mm. This is smaller than the minimum diameter of most femoral nailing systems. The T2™ humeral nailing system's nail is 7–9 mm in diameter, and the nail is bent 6° at 62 mm from the proximal end and 4° at 48 mm from the distal end. These curvatures similar to the trochanteric entry femoral nails. Because of this proximal curvature, the humeral nail should be inserted at the tip of the greater trochanter, rather than the piriformis fossa. Finite elements analysis (FEA) showed that 7 mm humeral nails have about 67% of the bending stress of 9 mm femoral nails, while torsion stresses are almost the same in the distal screw holes that receive the most stress. The T2™ humeral nailing system's nail had enough strength to stabilise the femur in our patients and post-operative casting was not necessary.

Operative positioning is a serious problem, as the usual traction table is not suitable due to deformity of the lower limb. Our patients were placed in a lateral or semi-lateral position which allowed the guide wire to be inserted with the hip flexed. Evaluation of the femoral alignment and repositioning of the fracture were easy using the image intensifier. Insertion of the distal interlocking screws was also straightforward with the patient in the lateral position.

We believe this technique is useful in fractures of the femoral shaft in patients with severe cerebral palsy. If a suitable implant is not found, the T2™ humeral nailing system may be a useful device to stabilise these special fractures.

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